CHAPTER 8:
HUMAN FACTORS TRAINING

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LANDING PAGE

Aviation maintenance programs are built on a foundation of extensive training for AMTs and Engineers. Licensed Aviation maintenance technicians (in the U.S.) and Certifying Engineers (in other countries) undergo in-depth training related to the tasks they perform as part of their jobs. For the past 15 years, or so, there has been an increasing emphasis on the human factors aspects of aviation maintenance. The primary human factors topics, which are discussed in other parts of this Guide, include general knowledge of human factors, human error, fatigue, facility design, procedures, shiftwork, ethics, and the programmatic aspects of human factors.

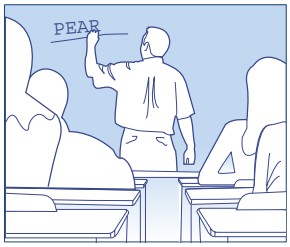
As regulatory and maintenance organizations have become more aware of the human factors aspects of aircraft maintenance tasks, the concepts, methods, and empirical knowledge of human factors have made their way into the AMT training curriculum. Non-U.S. regulatory agencies have taken the lead in this regard, but the FAA will eventually incorporate human factors into the training curriculum required for AMT certification. These training components will become more relevant and critical as airlines and maintenance organizations implement safety management systems (SMS) in compliance with International Civil Aviation Organization (ICAO) requirements.

This section of the Human Factors Guide describes the basis for human factors training in the aviation maintenance domain. It also provides guidance regarding the most important factors associated with “good” human factors training.

INTRODUCTION

Human factors training programs are hardly new. It is generally agreed that Continental Airlines established the first training program in about 1990, known as Crew Coordination Concepts (CCC). As the concept evolved, US Airways (then US Air), with cooperation of FAA, adopted the CCC approach, restructuring and renaming it Maintenance Resource Management (MRM). The name, MRM, aligned the new maintenance training with the growing success of the flight operations Crew Resource Management. As the programs evolved, institutions

quickly recognized that the human factors training initiatives would be successful only as they expanded throughout the organization.

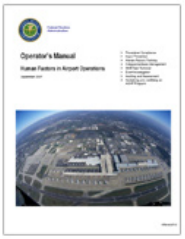


Since 1989, FAA has sponsored an extensive maintenance human factors research program, and has sponsored and co-sponsored 20 major industry conferences on human factors in maintenance and inspection, adding ramp safety in 2006. The majority of the research reports and conference proceedings are available at the FAA human factors website www.hf.faa.gov.

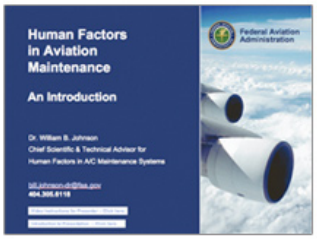
In general, maintenance organizations are determined to meet or exceed regulatory training requirements. However, their primary goal is to design and deliver cost effective training that will enhance human performance, increase quality, and reduce errors. In an attempt to satisfy these objectives organizations address the following questions (and others):

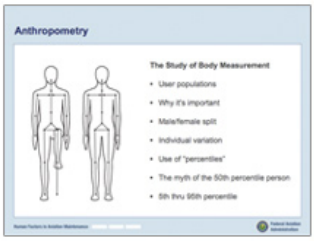
- How do I ensure that my training will be acceptable to my national regulatory authority?
- To whom must the training be delivered?
- What are the key topics that I must cover?
- How do we ensure that the training is matched to our company needs?
- How much is enough?
- What training techniques are most applicable?
- Who should deliver the training and how can we qualify the trainers?
- How do we select an outside provider if we choose to do so?
- How can we cost justify the training?

The FAA and the aviation maintenance industry have worked together to produce a number of guidance documents that include the topic of human factors training. In 2005, FAA teamed with industry to publish the *Operator's Manual for Human Factors in Maintenance*. In 2007, another FAA-industry team published the *Operator's Manual for Human Factors in Airport Operations*. Both of these short "how to' manuals address training and are available on the FAA website.



In 2007 – 2008, FAA created the Maintenance Human Factors Presentation System (MHFPS). Distributed via DVD, the MHFPS is a tool to deliver human factors training. It is comprised of 170 PowerPoint slides, 40 animations, and 11 short videos. An address to obtain the MHFPS is on the FAA human factors website, or simply contact the author.





This chapter is not a theoretical treatment of either the fundamentals of training development or maintenance human factors. Instead, it describes the most relevant issues related to initial and recurrent maintenance human factors training. We suggest the use of the instructional systems development (ISD) process. However, the chapter is based on many current time-tested human factors training programs and does not suggest that readers reinvent human factors in order to establish and continue an effective program.

REGULATORY REQUIREMENTS

The regulations of one's National Aviation Authority (NAA) are often the starting point to define the minimum human factors training requirements. After all, the organization must be in compliance, so this is a reasonable primary information source. With proper attention to accepted practices of instructional design and delivery, the NAA mandates are sufficient to ensure the existence of high value human factors training.

There is no doubt that the presence of regulations affects the implementation of human factors programs. A 2006 international survey showed that the most robust and extensive maintenance human factors programs were in the countries where it was a regulatory requirement.

The international regulations on maintenance human factors training vary. Some countries have requirements for teaching general human factors knowledge and specific training for initial mechanic/engineer certification; introductory training for all maintenance workers and managers; and recurrent training for everyone. That is the case with Transport Canada, the European Aviation Safety Authority (EASA), the Civil Aviation Safety Authority (CASA) in Australia, and other NAAs. Currently, the US FAA does not have mandates on initial or recurrent human factors training. Table 8-1 shows a listing of the human factors training requirements for some NAAs and their regulation references.

Table 8-1. Comparison of maintenance human factors training requirements			
	FAA	**EASA**	**Canada**
Regulation	None	• Part 66 • Part 145 (Part 147) (only within approved basic training. All other HF trainings could be performed by 147, or 145, or own personnel, or contractors, or, or, or)	STD 566 CAR 573.06, STD 573.06
Required Hours	None	Not specified. Based on approval of the individual training course. (Within approved basic training usually 2—3 days.) *CAP716 recommends 3 days for initial training and 1 day for continuation training	16 Initial
Continuation Training	None	• Must undergo continuation training before 24 months elapse • Must be of sufficient duration and based on a program acceptable to Authority.	• Update training is performance based and determined by the organization in accordance with an approved cycle. Usually not to exceed 36 months. • Additional training as required determined by quality assurance program findings.
Guidance Documents	Ops Manuals HF Guide AC120-72 8300.10 HBAW 05-04	•CAP 716 • AMC 145.A.30(e) • GM 145.A.30(e) • ICAO HF Digests and Training Manual.	• HPIAM: TP 12863 Human Factors for Aviation **Basic Handbook**, Printed Publication • TP 12864 Human Factors for Aviation **Advanced Handbook**, Printed Publication • TP 12865 Human Factors for Aviation **Instructor's Guide**, Printed Publication • FRMS: TP 14572, TP 14273, TP 14574, TP 14575, TP 14576 & TP 14578

In this global aviation environment, organizations typically follow the strictest of the applicable regulations. This means that a large portion of the world, including about 30% of US maintenance organizations, usually comply with the rules of EASA. As a result, the large organizations throughout the world are essentially working under the EASA regulations. Of course, the same regulations may evolve to international harmonization over time.

In 2000, FAA published Advisory Circular (AC) 120-72 Maintenance Resource Management Training. This document remains relevant today. While some of the terminology has changed, the fundamentals of maintenance human factors training programs have not. The FAA Advisory Circular is complemented by an extensive document published by the Civil Aviation Authority (CAA) of the United Kingdom in 2003, entitled CAP 716. This UK document offers guidance on training programs as well as all aspects of human factors programs for maintenance. Both documents are “required reading” for those working in maintenance human factors.

CONCEPTS

The following concepts are but a small subset of those related to training program development. However, we are not attempting to provide a detailed “how to” guide for training development. These concepts will help readers understand the discussion in this chapter.

Curriculum

A curriculum is simply a list of topics that will be covered in a training course or even an entire training program. For example, there is an established curriculum for training people to become AMTs.

Dirty Dozen

In the 1990s, Transport Canada introduced a list of the most common sources of errors in aviation maintenance. This list is known as “The Dirty Dozen” and it has been widely distributed in the aviation maintenance community. Table 8-2 is a list of the Dirty Dozen, and includes a brief explanation of each cause for error.

Table 8-2. The Dirty Dozen	
1. Lack of communication	7. Lack of resources
The exchange of information that conveys meaning between two or more people. Lack of communication often leads to misunderstandings and the results could be catastrophic.	Failing to use or acquire the appropriate tools, equipment, information, and procedures for the task-at-hand. Lack of resources or misusing resources has been linked to many accidents or incidents.
2. Complacency	8. Pressure
Self-satisfaction accompanied by a loss of awareness of the dangers. This often happens when doing familiar, repetitive work.	Pushing for something, in spite of opposing odds, or creating a sense of urgency or haste. This factor is most prevalent when deadlines approach or when trying to meet a tight schedule.
3. Lack of knowledge	9. Lack of assertiveness
Insufficient experience or training in the task-at-hand. It is easy to see how lack of knowledge could lead to an error or an accident. Often lack of assertiveness plays a part because people do not like to admit they do not know something.	Failing to behave in a self-confident manner. Lack of assertiveness has been identified as a link in the chain of events for many accidents.
4. Distraction	10. Stress
One's attention is drawn away; mental or emotional confusion or disturbance occurs. When working among many people, with frequent work interruptions, or when coping with stress, it is easy to become distracted.	Mental, emotional, or physical tension, strain, or distress. Stress is not inherently good or bad; how one handles it determines its impact on the individual. Stress is very difficult to measure objectively.
5. Lack of teamwork	11. Lack of awareness
Failing to work together to achieve a common goal. Lack of teamwork creates an unhealthy environment in terms of personal dissatisfaction and group disconnect.	Failing to be alert or vigilant in observing. Lack of awareness of the work situation or your surroundings often results in error or injury to yourself or others.
6. Fatigue	12. Norms
Weariness from labor or exertion, nervous exhaustion, temporary loss of power to respond. Shift work can have an enormous physical impact, but there are ways to combat fatigue. For example, sleeping and exercising regularly, avoiding complex tasks at the bottom of the circadian rhythm, and asking others to check the work.	Unwritten and, often, unspoken rules about how work is done. Always work according to the instructions. If norm are actually a better way to do things, change the instructions so norms become part of the approved procedures.

Initial Training

Initial training is provided for students who have had no previous training on the particular topic. Often, initial training consists of an introduction to the fundamental concepts and methods of human factors.

Learning Objectives

In a top-down training development process, such as Instructional System Development (link to ISD, below), the starting point for deciding what material goes into the training course is identifying what students should know or be able to do when they complete the course. These elements are called learning objectives, i.e., the objectives of taking the course is to be able to know or do them at the end.

Recurrent Training

As its name implies, recurrent training, is given after the initial training is completed. It can be "refresher" training, which is a condensed version of initial training, or it can expand the initial training to cover a broader range of material or to delve deeper into specific subject matter. The term "recurrent" implies that this type of training is taken on a periodic basis, not just one time. Recurrent training is sometimes called "continuation" training, since it can be viewed as a continuation of the initial training.

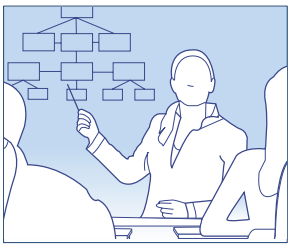
Train the Trainer

This is a common term in the training world. It simply means bringing an individual up to a level of knowledge and skill that permits him or her to teach others the subject matter of a course. For human factors training in aviation maintenance, the "trainer" who is being trained to teach the course(s) is often, but not always, an instructor who has experience teaching non-HF material.

METHODS

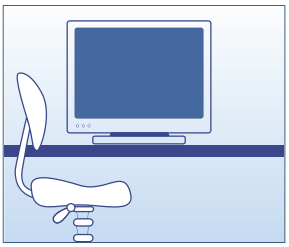
Classroom Instruction

Classroom instruction is what most people envision when they think of training. Typically, classroom instruction involves one, or more, instructor standing in front of the students. The majority of human factors training is delivered in the classroom. In many cases, the human factors training classroom is arranged in a circle or around conference tables. Such seating arrangement promotes discussion. Most classrooms also need some way to break into small groups.



Computer-Based Training (CBT)

Computer-based training can take many forms, but always involves students interacting with either an instructor or pre-programmed training modules via a computer. There are a few international computer-based training offerings. In most cases, the CBT is used for the initial delivery of declarative knowledge and initial fundamental proficiency testing. It is usually accompanied with a day or more of group interaction with the human factors trainer.



Instructional System Development (ISD)

ISD is a top-down process that systematically identifies learning objectives, supporting knowledge and skills, and instructional methods. The end product of ISD is typically a course syllabus, lesson plans, and supporting materials, such as handouts, videos, etc. A good source of information on structured training program development can be found in Advisory Circular 145-10.

On-the-job Training (OJT)

As the name implies, on-the-job training, or OJT, is accomplished while the student is working on real maintenance tasks. Typically, OJT consists of assigning a student to a mentor, i.e., an experienced AMT/Engineer. The mentor (trainer) demonstrates how to perform specific tasks and monitors the student's progress until they reach the required level of proficiency. The usefulness and efficiency of OJT depends almost entirely on the ability of the mentor to teach the student the required knowledge and skills.

Remote Learning

The simplest definition of "remote learning" is any type of instruction that does not occur in a classroom or on the job. Usually, remote learning involves using computers and video links to build a virtual classroom. Remote learning typically allows participants to engage an instructor via a voice or video chat link, to see and hear an instructor giving lecture presentations (complete with white board and PowerPoint presentations), and to take part in class discussions. This training method is not (currently) used extensively in the aviation domain.

GUIDELINES

The information in this section of the chapter is meant to be practical, not theoretical. The individual guidelines have been derived from long experience in the aviation maintenance-training domain.

Teach the Sources of Human Error

There is general agreement that human error is the primary or a contributing factor in 80% (or more) of major accidents. People routinely commit errors that result in injuries, damage to equipment, regulatory non-compliance, breaches of flight safety, and more. The goal of human factors training is to help workers recognize the situations that can lead to error, see them as contributing factors, and identify the corrective actions that reduce the likelihood of error.

Some human factors trainers have used the PEAR model to show the major categories of factors that contribute to human error. Regardless of whether the PEAR model is used explicitly, the factors contained in the PEAR categories must be addressed in training. The PEAR model is more fully described in Chapter 1. Figure 8-1 shows an overview of the PEAR categories.

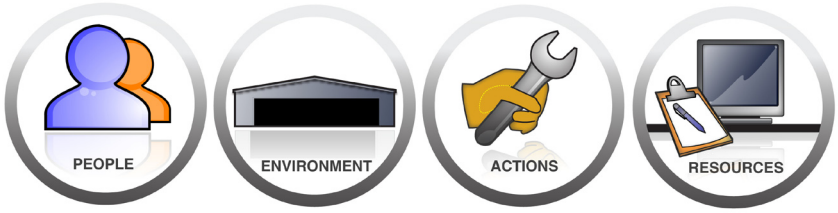


Figure 8-1: *The PEAR model*

P stands for People. It includes factors such as fitness for duty, physical characteristics, certification, and the mental and skill requirements necessary to complete the task. E stands for the work Environment, which includes both physical social, and organizational factors. The A represents all of the Actions necessary to complete a maintenance task, and R indicates the resources necessary to complete the job.

A lot of fundamental science related to human error underlies models like PEAR or concepts like the Dirty Dozen. However, aviation maintenance human factors training is best when delivered in plain language with straightforward concepts that can be applied at work.

Necessary Elements for Successful Human Factors Training

Each organization designs and implements a slightly different human factors training program matched to their specific challenges and corporate culture. However, there are common elements of successful human factors training across the industry. Examples of these common elements include:

- Senior management support
- Training for everyone
- Reporting and managing error
- Continuous communication and feedback

Senior management support. The foundation of any successful organizational program is senior management support. Senior managers must have the vision and commitment to reduce maintenance errors and increase safety with sustained attention to maintenance human factors issues. When top decision makers clearly support the mission and purpose of human factors programs, a positive organizational culture change is more likely. Without such a commitment, a pervasive organizational change is unlikely.

Training for everyone. Human factors training must extend across all the levels of an organization. It cannot be limited to certificated or return-to-service personnel. It must extend from the cleaning crew to the responsible executive of the organization. In fact, this is a requirement in the EASA and Transport Canada regulations (See EASA GM AMC 145.A.35 (e) 6).

Experience has shown that it is the middle managers and supervisors—often evaluated by their ability to control costs and on-time performance—who often become the weak links in the application of human factors programs. For that reason, their training requirement is equal to that of all other workers. These individuals interact daily with the workers who are ultimately responsible for carrying out the new strategies. Mid-level managers also need the support of upper-level management in applying the new human factors approaches in the field. With proper training, middle managers are more likely to use their understanding of human factors to push and manage a cultural change.

Reporting and managing error. If human factors training is going to be effective at reducing errors, workers must be able to transfer the concepts and language of the training directly into the workplace. Chapter 7 (need link here) discusses event investigation tools like Boeing's Maintenance Error Decision Aid (MEDA), the importance of voluntary reporting, and a "just culture." The industry acceptance of the FAA's Aviation Safety Action program (ASAP) is another excellent source of information. Note: Need link to ASAP here http://www.faa.gov/safety/programs_initiatives/aircraft_aviation/asap/. Peer observations/audits of normal performance are another high value means to identify opportunities to identify not only positive actions but also actions that can be improved.
Maintenance human factors training is successful when workers are able to recognize the challenges associated with PEAR or the Dirty Dozen and report these in a proactive manner. The total human factors program is successful only when management makes and tracks changes based on workers' reports.

Continuous feedback. Incorporating human factors into the fabric of an aviation maintenance organization is usually a cultural change. Continuous communication and feedback must occur in order to sustain the change process. Several communication channels exist to distribute the results of human factors training programs. These include newsletters, group meetings, person-to-person discussions, public bulletin boards, e-mail, etc. The idea is to provide

managers and workers with information on the type of actions occurring in the workplace and their effect on the company's overall performance (i.e., quality, safety, dependability). (Link here to the Communication chapter.)

The Human Factors Trainer

Who should deliver human factors training? That is a question without a set answer. The primary concerns regarding human factors trainers center on the professional, academic, and maintenance experience of the potential instructor. For example, should the instructor have a college degree in psychology or human factors, an A+P (engineering) certificate, a minimum number of years of maintenance experience, extensive teaching experience, or some combination of these qualifications? There is no precise answer. In lieu of listing prerequisites for a human factors instructor it is better to describe what the instructor must be able to do.

Instructors should understand the aspects of human factors by embedding them into all the training curricula. To accomplish this, instructors must—

- Be able to garner attention and respect based on their ability to communicate human factors topics clearly and effectively.
- Demonstrate and communicate an applied understanding of fundamental human factors principles as they apply to aviation maintenance work environments.
- Demonstrate credibility as a human factors instructor based on academic credentials, maintenance certification, working experience, teaching experience or a combination thereof.
- Have excellent communication and motivational skills; be able to effect attitude changes; and impart knowledge.
- Follow instructional plans and procedures and adapt the plans based on audience requirements.
- Be able to promote and lead interactive classes using industry "lessons learned" relative to the subject matter, including associated costs and personnel injuries.
- Debrief students after practical examinations. Openly discuss mistakes and potential ramifications along with how to avoid these traps on-the-job.
- Advocate the training department's knowledge, experience, and lessons learned to other departments throughout the organization.

Training the Trainer

Maintenance human factors trainers should have taken formal courses in the art and practice of being a teacher. They should also have taken one or more formal maintenance human factors courses. Any aircraft systems instructor is prepared to discuss far more about an aircraft than the information in the course syllabus. This should also be true for the human factors instructor. The trainer must be able to add value to the prepared script and be able to answer unexpected inquiries.

There are many human factors courses offered by training companies, colleges, and universities worldwide. There are also many human factors symposia that help prepare attendees to develop a broad understanding of human factors programs and procedures. It is unlikely that a trainer can be fully prepared without the benefit of such outside resources. The company must make the commitment to ensure that the external training happens.

Instructors should be strongly competent as trainers and as human factors practitioners. They should also know (or learn) something about the actual operations in maintenance organizations. Instructors learn a lot about aviation maintenance as human factors trainers. However, they should also learn as much as possible about maintenance prior to the first class.

An effective way to prepare human factors trainers is to permit them to co-teach a number of classes in advance of teaching the class alone. For human factors training programs, co-facilitation is a luxury that provides the opportunity for two representative workers to actively present and facilitate the instructional process.

Experience using two instructors has shown it is best when mechanic/engineers co-facilitate with human factors experts. Together, they can be a dynamic team representing a valid combination of knowledge and work experience. Additionally, they can respond to course participants with examples and scenarios that demonstrate the human factors concepts being presented. After a few classes, the respective parties are able to enhance their strengths in both human factors and maintenance.

While a two-instructor class is ideal to qualify instructors, it is also expensive. Some training companies insist on “co-facilitation” of human factors classes. Each company or training system provider must decide what arrangement of instructors works best for their situation. In most cases, one qualified instructor is sufficient.

Human Factors Training Curriculum

Educators and professional instructional designers rightfully argue that a company should conduct job and task analyses to determine the contents on a human factors course. With respect to maintenance human factors that may have been true in the early 1990s. Since then, there has been significant research, development, evaluation, and evolution regarding content and training design for maintenance human factors. In fact, many regulations and guidance materials list the general areas that an initial class must include.

Before deciding what the training curriculum should include, a company must differentiate between initial and recurrent training. Initial training, as described in EASA Part 66.9.1 (Human Factors) and Transport Canada Part V, Standard 573.05, is typically required for certification as an AMT or Certifying Engineer. The curriculum for initial training tends to be much broader than that for recurrent training. In recurrent training, it is possible to assume that the participants will already have a general working knowledge of human factors concepts, methods, and data.

Maintenance human factors experts and regulatory agencies, including the FAA and EASA, have identified the following key topics that are likely to be included in a training program. The FAA Operator's Manual for Human Factors in Maintenance (Note: Put in a link to the Ops Manual) also includes this list and a discussion of these topics.

- General/introduction to human factors
- Safety culture/organizational factors
- Human error—error principles, event investigation and case studies
- Human performance and limitations
- Fatigue management and general fitness for duty
- Environment—physical and social
- Procedures, information, tools, and task sign-off practices
- Planning of tasks, equipment, and spares
- Communication
- Teamwork and leadership
- Professionalism and integrity
- Shift and task turnover
- Undocumented maintenance
- The 12 common human errors (Required by Transport Canada Part V, Standard 573.05)

An organization should select topics from the list above based on its requirements. The Safety Management System (SMS) and data from various event-reporting systems define the needs. The essence of a human factors training program is as much about how to select the content as it is about the delivery methods. Defensible training program design will help ensure compliance with the NAA and other appropriate regulators.

Cost Justification of Training

The FAA Operator's Manual for Human Factors in Maintenance offers a chapter on cost justification of human factors programs. The chapter recognizes that it is very difficult to match a specific intervention to a specific prevention. It offers a plan to show how one small intervention at a time contributes to a significant safety impact and cost reduction.

WHERE TO GET HELP

Aeronautical Repair Station Association
www.arsa.org

Embry-Riddle Aeronautical University
http://amelia.db.erau/hfami/index.html

European Aviation Safety Agency (EASA)
www.easa.eu.int

Federal Aviation Administration (FAA)
There are a number of human factors resources within the Federal Aviation Administration.

www.hf.faa.gov
www.faasafety.gov

A direct link for aviation maintenance is the Senior Scientific and Technical Advisor for Human Factors in Aviation Maintenance.

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Human Factors and Ergonomics Society
The HFES is the only organization in the United Stated dedicated specifically to the Human Factors profession. The HFES was formed in 1957 and typically maintains about 5,000 members. It includes a Technical Interest Group on Training. The organization headquarters is in California.

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EXAMPLE SCENARIO

You are the Training Manager for the maintenance division of a European airline. The Technical Operations Quality Manager of an organization that holds an EASA 145 certificate tells you that it is about time to develop new recurrent training related to Human Factors for the up-coming EASA audit, which will occur in a few months. You ask two of your most experienced trainers to look over the current course offerings, suggest a new recurrent training course, and then develop it. You give them two weeks to do the needs analysis and then make recommendations for the new course.

The two trainers come back to you with the following observations and recommendations:

- The initial 2-day HF training course seems to be adequate. End-of-course evaluations have been positive and the trainers have received e-mail from mechanics relating human factors stories from the hangar floor. The trainers have incorporated some of these stories into each class. They want to broaden the scope of the curriculum for the new recurrent training class.

- Their search of the regulations brought them to EASA Part 145.A.35 (d), which covered continuation training. The continuation training has to take place every two years and has to cover, at a minimum, a) relevant technology, b) organizational procedures, and c) human factors. They found that there are no specific minimum time requirements for delivery as long as it is within the 24-month period. The training has to be delivered to all personnel within the maintenance organization, from sweepers to the Accountable Executive.

- This “relevant technology” and “new procedures” sections of the EASA regulations are already being adequately addressed by existing training. There is no continuation training for human factors, so the recommendation is to concentrate on human factors in the new course. They recommend that the continuation training should review human factors fundamentals, give the students human factors memory joggers, and review the lessons learned from recent events in the company or the industry

- They recommend that the new continuation course be a total of 4 hours long, delivered in two 2-hour segments over a two-week period.

The remaining issues relate to how the new training program can be efficiently developed.

While searching Google the trainers find the FAA’s new (2008) Maintenance Human Factors Presentation System (MHFPS) and send an e-mail requesting the DVD. The MHFPS gives the trainers a pre-developed human factors training presentation. It contains 170 PowerPoint Slides that can be modified to show their company name and image. The system also has 40 animation files and 11 FAA videos that can be used for discussion.

They use the MHFPS to talk about human error, fatigue, and a unique way to look at maintenance human factors at work and at home. The MHFPS introduces the class to the PEAR model. PEAR is an acronym that encompasses people, the environment in which they work, the actions they perform, and resources necessary to perform the work. The PEAR categories are then integrated into the event discussions.

The end result is a success. The students like the class. Management likes the content and the scheduling flexibility. The FAA-EASA audit team really appreciates that the company chose the FAA software and modified it to meet their specific training requirements. Your trainers have made you look very good.

The trainers continue to work diligently at their current aviation employer. However based on their recent success as instructional designers and human factors trainers they are now checking Monster.com to find safety jobs in a more economically secure industry.

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